



FUNCTIONAL OUTCOME OF DISTAL END OF RADIUS FRACTURES WITH INTRA ARTICULAR EXTENSION TREATED WITH VOLAR LOCKING COMPRESSION PLATE IN ADULTS - A PROSPECTIVE STUDY

Orthopaedics

Dr Venkatesh M	Department of Orthopaedics ,Aarupadai Veedu Medical College and Hospital.
Dr Kamalesh T	Department of Orthopaedics ,Aarupadai Veedu Medical College and Hospital.
Dr Abraham M Antony	Department of Orthopaedics ,Aarupadai Veedu Medical College and Hospital.
Dr Boblee James	Department of Orthopaedics ,Aarupadai Veedu Medical College and Hospital.
Dr Rijin P.S	Department of Orthopaedics ,Aarupadai Veedu Medical College and Hospital.
Dr Gokul Anand M*	Department of Orthopaedics , Aarupadai Veedu Medical College and Hospital. *Corresponding Author

ABSTRACT

Background: Distal radius fractures are quite common. Distal radius integrity is important for radio-carpal and radio-ulnar joint kinematics. **Objectives:** To assess the outcomes of distal end of radius fractures with intra articular extension treated with volar locking compression plate when indicated leads to early functional recovery. **Methods:** This was a prospective interventional study designed to assess the functional outcomes of distal end of radius fractures of 30 skeletally matured patients treated by internal fixation using locking compression plate conducted between September 2018 and August 2020 at a tertiary care health facility. The study outcomes were assessed using Mayo Wrist Score. **Results:** The mean (SD) age of the patients was 40.37 years (12.7) and majority were males (76.7%). Road traffic accident was the most common reason for the injury (56.7%). Majority of patients belonged to Class III (40%) based on Frykman classification. The mean (SD) palmar flexion, dorsi flexion, supination, pronation, radial deviation, and ulnar deviation was 66.5 (11.1), 66.8 (10.6), 78.5 (8.3), 77.8 (8.4), 13.7 (2.3) and 24.5 (7.1) respectively. The mean (SD) Mayo Wrist Score was 82.3 (7.2); and the median (IQR) Mayo Wrist Score was 85 (75 to 85). The result showed that majority of patients had good result (56.7%), 23.3% had fair result and 16.7% had excellent result. None of the independent variables (age in years, gender, mode of injury and Frykman classification) were statistically associated with the results ($p > 0.05$). **Conclusion:** The volar locking compression plates provide good to excellent results and are effective in the correction and maintenance of the distal radial anatomy and allows free joint motion and early return to functional activities.

KEYWORDS

Distal radius fracture, volar locking plate, Mayo wrist score, Frykman classification, Prospective study

INTRODUCTION

Distal radius fractures are very common injuries, accounting for 16% of all emergency room fractures treated and comprising of 74.5% of all fractures.(1, 2) These fractures appear to undergo secondary displacement.(3, 4) These fractures tend to undergo secondary displacement following conservative therapy.(4) Since distal radius is important for radio-carpal and radio-ulnar joint kinematics,(5) open articular surface reduction, radial length reconstruction, volar angulation and radial inclination are pre-requisites for successful clinical performance.(6, 7) In order to minimise post traumatic osteoarthritis and early functional rehabilitation, reconstruction of articular congruity and stable fixation is important for distal radius foundation of the wrist joint and indispensable part of ligament support.(8) The primary treatment of distal radius fractures was managed under closed reduction and cast immobilisation, Kirschner wire fixation, external fixation and open reduction and internal fixation.(9, 10) Loss of reduction is a prevalent issue related to cast immobilisation.(11) Soft tissue necrosis, compartment syndrome, neurovascular damage are other complications due to cast immobilisation.(12) Cutaneous nerve and vessel damage, tendon attrition rupture, chronic regional pain syndrome, pin migration, pin fracture, inflammation and loss of reduction are complication due to k-wire fixation.(13) Recent literature explains the advantages of volar locking plates over dorsal plate and external fixators.(14, 15) External fixators require joint immobility, which can lead to potential muscle atrophy, disuse osteopenia and joint capsule tightening.(16) This complicates recovery and functional outcomes, especially for osteoporotic patients.

Dorsal plates, due to their proximity to the extensor tendon, bear the possibility of tenosynovitis and tendon rupture. Volar plates decrease the risk described above and have improved the outcome of distal radius fracture treatment. In addition, volar locking plates increase the reliability of fracture repair and are crucial to achieving the objective of securing early post-operative range of motion.(15) This technique has become an essential instrument in the management of distal end of radius fractures with a better understanding of the concepts of the volar locking compression plate.(17) Against this background, the aim of the

study is to assess the outcomes of distal end of radius fractures with intra articular extension treated with volar locking compression plate when indicated leads to early functional recovery.

MATERIALS AND METHODS

This was a prospective interventional study designed to assess the functional outcomes of distal end of radius fractures of 30 skeletally matured patients treated by internal fixation using locking compression plate. The study was conducted between September 2019 and August 2022 at Department of Orthopaedics and Traumatology, Aarupadai Veedu Medical College & Hospital.

The study included both male and female patients who is more than 18 years of age with closed fractures, radiological diagnosed distal end of radius fractures with/ without intra articular extension, presenting with no neurological complication. The patients with open fractures of age less than 18 years presenting with nerve injuries and not giving consent were excluded.

Surgical procedure:

The surgical procedure was done in the Department of Orthopaedics and Traumatology, Aarupadai Veedu Medical College & Hospital, Puducherry. The distal radius fractures were treated with open reduction and internal fixation with volar locking compression plate.

Following a pre-operative review, all procedures were performed under regional anaesthesia or general anaesthesia at the anaesthetist's discretion. All cases were done through Modified Henry approach.

Postoperative Protocol:

One dose of antibiotic is given half an hour before surgery after sensitivity test and two doses of post-operative antibiotics was given. All the patients were kept in limb elevation after surgery to reduce the swelling. All patients treated with Volar LCP were advised to start early active range of motion of the wrist and hand as tolerated. Some patients are immobilized for four to six weeks based on the fracture pattern, reduction, and stability with active finger mobilization and gradual wrist mobilization was initiated later on. Sutures were removed on the

twelfth day after surgery. The patients were not allowed lift heavy weights for twelve to sixteen weeks.(23)

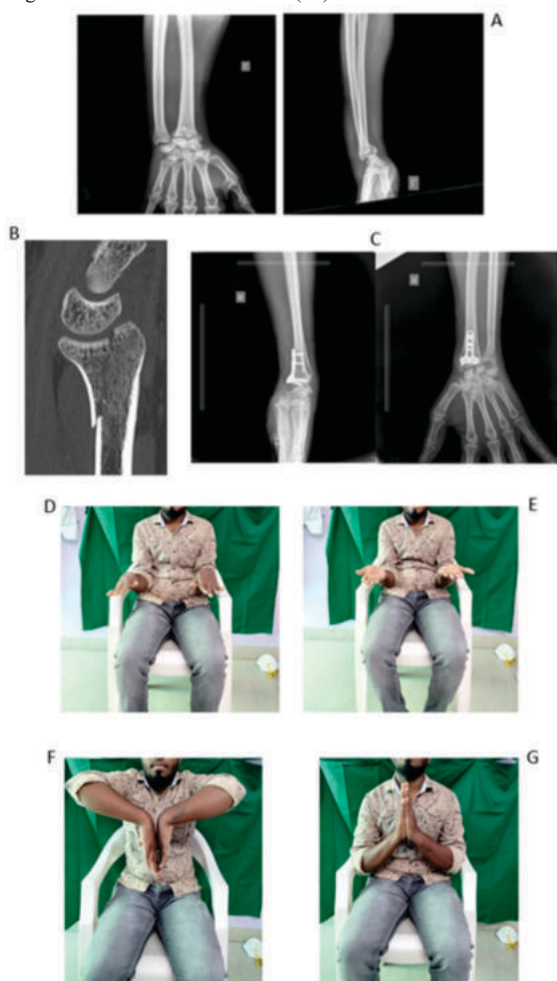


Figure 1: A, Preoperative X rays; B, Preoperative CT image; C, Postoperative X rays; D, Pronation; E, Supination; F, Palmar flexion; G, Dorsi flexion

RESULTS

In the present study majority of patients were between 30-50 years of age (63.3%) (Table 1). The mean (SD) age of the patients was 40.37 years (12.7). The median (IQR) age of the patients was 39 years (30 to 50). Majority of the patients were male (76.7%) and 23.3% of patients were female. Of 30 patients included in the study, 50% each had an in their left and right side. Road traffic accident was the most common reason for the injury (56.7%), followed by self-fall (43.3%). The results show that majority of patients belonged to Class III (40%) based on Frykman classification. More than one in four (26.7%) were classified in Class II and one in five (20%) were classified in Class I.

Table 1: Descriptive Characteristics Of The Study Population

Variables		No. of Cases (n)	Percentage
Age (in years)	Less than 30 years	5	16.7%
	30-50 years	19	63.3%
	Greater than 50 years	6	20%
Gender	Male	23	76.7%
	Female	7	23.3%
Side of involvement	Left	15	50%
	Right	15	50%
Mode of injury	RTA	17	56.7%
	Self-fall	13	43.3%
Frykman classification	Class I	6	20%
	Class II	8	26.7%
	Class III	12	40%
	Class V	3	10%
	Class VI	1	3.3%

The mean (SD) palmar flexion, dorsi flexion, supination, pronation, radial deviation, and ulnar deviation was 66.5 (11.1), 66.8 (10.6), 78.5 (8.3), 77.8 (8.4), 13.7 (2.3) and 24.5 (7.1) respectively.

The mean (SD) Mayo Wrist Score was 82.3 (7.2); and the median (IQR) Mayo Wrist Score was 85 (75 to 85). The result showed that majority of patients had good result (56.7%), 23.3% had fair result and 16.7% had excellent result. The study also found that 3.3% of patients had poor result (Figure 2).

We also explored the association between the independent variables (age in years, gender, mode of injury and Frykman classification) and the results. However, none of the independent variables were statistically associated with the results ($p > 0.05$).

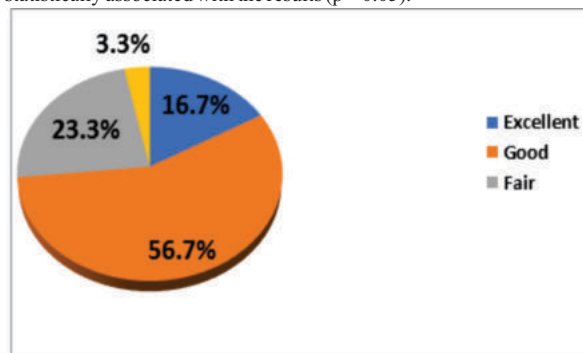


Figure 2: Distribution of results

DISCUSSION

The distal end of the radius fracture appears to be one of the upper limb's most common skeletal injury. These fractures are mostly articular injuries that cause both the radiocarpal and distal radio-ulnar joints to be disrupted. In order to achieve good functional results and to prevent late osteoarthritis, restoration of normal alignment, length and articular congruity has proved to be vital. Comminuted intra-articular fractures are highly unstable.(24) After an anatomical joint reduction is achieved, it is important to connect the articular segment to the shaft while preserving adequate alignment. It is difficult to achieve adequate stability for fracture-healing in the presence of metaphyseal or meta-diaphyseal comminution.(25-27) In these patients, the application of cast will lead to loss of reduction and a poor functional outcome.

Open reduction and early locking plate fixation restores normal anatomy, ensures stable fixation, and allows early mobilisation and early return to pre fracture state.(28) Palmar plating avoids violating the extensor compartment and the complications of irritation and rupture of the extensor tendon can be virtually eliminated.(29) There is also more room in the volar approach between the volar cortex and flexor tendons and pronator quadratus prevents complications of soft tissue such as flexor tendon injuries.(30) In order to avoid flexor tendon injuries, the volar plate should not be positioned distal to the watershed line. Radius slopes in a dorsodistal direction, distal to the watershed line, and palmarly becomes more prominent.(31) The course of Flexor pollicis longus is near to the distal radius of the palmar rim. Volar plates placed distal to the line of the watershed can therefore exert pressure on flexor tendons and cause injury.(32)

A transverse ridge that closes the concave surface of the volar radius distally is known as the watershed line. The stability of the locking plates at the angular-stable screw-plate interface is maintained. The pull-out power of locking head screws is considerably higher because of this secure monobloc of the locking internal fixator. Since the screws are fixed to the plate, unless all adjacent screws fail, it is hard for one screw to fall out or fail. In osteoporotic bones, the improvement in stability with locking plates is most helpful.(33) Distal screws must be positioned just under the subchondral bone for optimum support of the bone. The drill can, however, penetrate the radiocarpal joint, and a lateral radiograph of 30° can be used to decide if the screws have penetrated the articular surface of the radius.(34)

The length of the screws is usually difficult to calculate, so it is best to radiographically check the length after the first screw is inserted. In order to prevent impingement of the ulnar portion of the plate on the distal radioulnar joint, it is necessary to properly position the plate. Also, since only one plate is needed, and the plate does not rely on a

tight fit to the bone for stability, it can require significantly less dissection of soft tissue, thereby maintaining the local blood supply and improving fracture healing.

Table 2: Comparison Of Functional Evaluation In Similar Other Studies

	Very good (%)	Good (%)	Satisfactory (%)	Bad (%)
Jupiter et al(35)	63	20	17	-
Dennison et al(36)	80	20	-	-
John K Bradley et al(37)	44	12	44	-
Anakwe et al(38)	24	60	16	-
Our study with VLCP	16.7	56.7	23.3	3.3

In the present study more than half (56.7%) had a good result after using volar locking compression plate on Mayo wrist score. The relative comparison between other similar studies is in Table 2. However, it should be noted that all the fracture of distal radius are not amenable to volar locked plating. This includes dorsal Barton fracture, dorsal intra articular extension and fracture of the dorsoulnar aspect of the sigmoid notch of radius.(39)

CONCLUSION

A displaced palmar articular fracture, Barton fracture and displaced extra articular fracture (colle's and smith) and volar displaced lunate facet fracture can be best managed with open reduction and internal fixation using a volar locking compression plate. LCP with combination holes gives the surgeons the opportunity to combine the principles of internal fixation and dynamic compression. Volar locking compression plate has proves to be effective with minimal to nil complications. Locking compression plates provide good to excellent results and are effective in the correction and maintenance of the distal radial anatomy and allows free joint motion and early return to functional activities.

REFERENCES

- Meena S, Sharma P, Sambharia AK, Dawar A. Fractures of distal radius: an overview. *J Family Med Prim Care*. 2014;3(4):325-32.
- Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. *Hand Clin*. 2012;28(2):113-25.
- Jung HW, Hong H, Jung HJ, Kim JS, Park HY, Bae KH, et al. Redisplacement of Distal Radius Fracture after Initial Closed Reduction: Analysis of Prognostic Factors. *Clin Orthop Surg*. 2015;7(3):377-82.
- Daniels AM, Janzing HMJ, Wyers CE, van Rietbergen B, Vranken L, Van der Velde RY, et al. Association of secondary displacement of distal radius fractures with cortical bone quality at the distal radius. *Arch Orthop Trauma Surg*. 2021;141(11):1909-18.
- King GJ, McMurtry RY, Rubenstein JD, Gertzbein SD. Kinematics of the distal radioulnar joint. *J Hand Surg Am*. 1986;11(6):798-804.
- Catalano L, Barron O, Glickel S. Assessment of Articular Displacement of Distal Radius Fractures. *Clinical orthopaedics and related research*. 2004;423:79-84.
- Karantana A, Handoll HH, Sabouni A. Percutaneous pinning for treating distal radial fractures in adults. *Cochrane Database Syst Rev*. 2020;2(2):Cd006080.
- Zhang H, Zhu Y, Fu F, Gou L, Zhu Y, Zhang Z, et al. Corrective Osteotomy with Volar and Dorsal Fixation for Malunion of Intra-Articular Fracture of the Distal Radius: A Retrospective Study. *Orthopaedic Surgery*. 2022;14(8):1751-8.
- Lin C, Sun JS, Hou SM. External fixation with or without supplementary intramedullary Kirschner wires in the treatment of distal radial fractures. *Can J Surg*. 2004;47(6):431-7.
- Kalantri A, Barod S, Kothari D, Kothari A, Bhambani P. Closed reduction, percutaneous Kirschner wire fixation and cast immobilisation of distal radius fracture-a prospective observational study. *JMSCR*. 2017;5:10.18535.
- Wendling-Keim DS, Wieser B, Dietz HG. Closed reduction and immobilization of displaced distal radial fractures. Method of choice for the treatment of children? *Eur J Trauma Emerg Surg*. 2015;41(4):421-8.
- Adani R, Mugnai R, Tarallo L. Vascular Lesions at the Elbow and Compartmental Syndrome. *The Elbow*: Springer; 2018. p. 321-30.
- Ratti C, Nordio A, Resmini G, Murena L. Post-traumatic complex regional pain syndrome: clinical features and epidemiology. *Clin Cases Miner Bone Metab*. 2015;12(Suppl 1):11-6.
- Çalbiyik M, Ipek D. Use of Volar Locking Plate Versus Intramedullary Nailing for Fixation of Distal Radius Fractures: A Retrospective Analysis of Clinical and Radiographic Outcomes. *Med Sci Monit*. 2018;24:602-13.
- Yu X, Yu Y, Shao X, Bai Y, Zhou T. Volar locking plate versus external fixation with optional additional K-wire for treatment of AO type C2/C3 fractures: a retrospective comparative study. *Journal of Orthopaedic Surgery and Research*. 2019;14(1):271.
- Levin SM, Nelson CO, Botts JD, Teplitz GA, Kwon Y, Serra-Hsu F. Biomechanical evaluation of volar locking plates for distal radius fractures. *Hand (N Y)*. 2008;3(1):55-60.
- Fu Q, Zhu L, Yang P, Chen A. Volar Locking Plate versus External Fixation for Distal Radius Fractures: A Meta-analysis of Randomized Controlled Trials. *Indian J Orthop*. 2018;52(6):602-10.
- Kasapinova K, Kamiloski V. Outcome evaluation in patients with distal radius fracture. *Prilozi*. 2011;32(2):231-46.
- Padegimas EM, Osei DA. Evaluation and treatment of osetoporotic distal radius fracture in the elderly patient. *Curr Rev Musculoskelet Med*. 2013;6(1):41-6.
- Handoll HH, Madhok R. Surgical interventions for treating distal radial fractures in adults. *Cochrane Database Syst Rev*. 2003(3):Cd003209.
- Xavier CR, Dal Molin DC, Dos Santos RM, Dos Santos RD, Neto JC. SURGICAL TREATMENT OF DISTAL RADIUS FRACTURES WITH A VOLAR LOCKED PLATE: CORRELATION OF CLINICAL AND RADIOGRAPHIC RESULTS. *Rev Bras Ortop*. 2011;46(5):505-13.
- Ochen Y, Peek J, van der Velde D, Beeres FJP, van Heijl M, Groenwold RHH, et al. Operative vs Nonoperative Treatment of Distal Radius Fractures in Adults: A Systematic

- Review and Meta-analysis. *JAMA Network Open*. 2020;3(4):e203497-e.
- Ikpeze TC, Smith HC, Lee DJ, Elfar JC. Distal Radius Fracture Outcomes and Rehabilitation. *Geriatr Orthop Surg Rehabil*. 2016;7(4):202-5.
- Karimi Nasab MH, Shayesteh Azar M, Fazel Moghaddam S, Taghipour M. Success Rate and Complications of Comminuted Intra-Articular Distal Radius Fracture Treatment via Closed Reduction and Use of a Mini-External Fixator. *Trauma Mon*. 2015;20(4):e18885.
- Chalidis B, Kitridis D, Givissis P. A New Surgical Technique and Clinical Outcomes of Operated Proximal Metadiaphyseal Humeral Fractures and Nonunions With the Use of Reversed Anatomic Distal Femoral Locking Plate. *Cureus*. 2021;13(9):e18309.
- Keating JF, Simpson AHRW, Robinson CM. The management of fractures with bone loss. *The Journal of Bone and Joint Surgery British volume*. 2005;87-B(2):142-50.
- Kim T, See CW, Li X, Zhu D. Orthopedic implants and devices for bone fractures and defects: Past, present and perspective. *Engineered Regeneration*. 2020;1:6-18.
- Savvidou OD, Zampeli F, Koutsouradis P, Chloros GD, Kaspiris A, Sourmelis S, et al. Complications of open reduction and internal fixation of distal humerus fractures. *EFORT Open Rev*. 2018;3(10):558-67.
- Abrego MO, De Cicco FL, Boretto JG, Gallucci GL, De Carli P. Extensor Tendons Rupture after Volar Plating of Distal Radius Fracture Related to a Dorsal Radial Metaphyseal Bone Spur. *Case Rep Orthop*. 2018;2018:8351205.
- Adham MN, Porembski M, Adham C. Flexor tendon problems after volar plate fixation of distal radius fractures. *Hand (N Y)*. 2009;4(4):406-9.
- Asadollahi S, Keith PP. Flexor tendon injuries following plate fixation of distal radius fractures: a systematic review of the literature. *J Orthop Traumatol*. 2013;14(4):227-34.
- Limthongthang R, Bachoura A, Jacoby SM, Osterman AL. Distal radius volar locking plate design and associated vulnerability of the flexor pollicis longus. *J Hand Surg Am*. 2014;39(5):852-60.
- Khatri K, Sharma V, Farooque K, Tiwari V. Surgical Treatment of Unstable Distal Radius Fractures With a Volar Variable-Angle Locking Plate: Clinical and Radiological Outcomes. *Arch Trauma Res*. 2016;5(2):e25174.
- Demirbaş E, Uğras A, Kaya I, Sungur I, Kural C, Cetinus E. Volar plate fixation of distal radius fractures. *Ulusal travma ve acil cerrahi dergisi = Turkish journal of trauma & emergency surgery : TJTES*. 2012;18:162-6.
- Jupiter JB, Marent-Huber M. Operative management of distal radial fractures with 2.4-millimeter locking plates: a multicenter prospective case series. *Surgical technique. J Bone Joint Surg Am*. 2010;92 Suppl 1 Pt 1:96-106.
- Dennison DG, Blanchard CL, Elhassan B, Moran SL, Shin AY. Early Versus Late Motion Following Volar Plating of Distal Radius Fractures. *Hand (N Y)*. 2020;15(1):125-30.
- Bradway JK, Amadio PC, Cooney WP. Open reduction and internal fixation of displaced, comminuted intra-articular fractures of the distal end of the radius. *J Bone Joint Surg Am*. 1989;71(6):839-47.
- Anakwe R, Khan L, Cook R, McEachan J. Locked volar plating for complex distal radius fractures: Patient reported outcomes and satisfaction. *J Orthop Surg Res*. 2010;5:51.
- Moore AM, Dennison DG. Distal radius fractures and the volar lunate facet fragment: Kirschner wire fixation in addition to volar-locked plating. *Hand (N Y)*. 2014;9(2):230-6.